

# PRECIOUS METAL SOLDER

by

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## CROSS-REFERENCES TO RELATED APPLICATION

[0001] This application is a divisional application of U.S. patent application serial no. 09/897,692 filed June 29, 2001, which is a continuation-in-part of U.S. patent number 6,372,060, filed February 14, 2000, both of which are hereby incorporated by reference into this application.

## BACKGROUND OF THE INVENTION

### 1. Field of Invention

[0002] The present invention relates generally to a solder composition and, more particularly, to a solder composition for assembling, repairing and/or sizing jewelry having a platinum content of up to about 95% by weight.

[0003] The present invention also relates generally to a solder composition and, more particularly, to a solder composition for assembling, repairing and/or sizing jewelry having a silver content of at least 92.5% by weight, and the balance being made of an alloy consisting of gallium, indium and copper in respective ratios of 6:3:1.

[0004] The present invention also relates generally to a solder composition and, more particularly, to a solder composition for assembling, repairing and/or sizing jewelry having a gold content of about 25% to about 91.6% by weight, and a mixture of other

metals including about 8% to about 80% silver, about 1% to about 66% copper, about 5% to about 31% zinc and about 0% to about 35% nickel, said solder composition consisting of 2-14% gallium, indium and copper, in respective ratios of 6:3:1.

**[0005]** A platinum or silver alloy consisting of gallium, indium and copper is used to lower the melting point of platinum and silver to provide a solder composition having a reduced melting point.

**[0006]** A gold alloy consisting one or more metals including silver, copper, zinc or nickel and further consisting of gallium, indium and copper to provide a solder composition having a reduced melting point.

**[0007]** More particularly, the platinum solders have melting temperatures in a range from about 1300° C (2372° F) to about 1500° C (2732° F), and the gold and silver solders melting temperatures in a range from about 1000° F (538° C) to about 1400° F (760° C).

## 2. Description of the Related Art

**[0008]** A variety of solder compositions are known in the art for repairing platinum, silver and gold jewelry. These prior art compositions are characterized by melting temperatures ranging from about 1000° C to about 1700° C and consist essentially of varying relative amounts by weight of gold, silver and/or palladium. The higher melting temperature solder compositions (1600° C and 1700° C) are difficult to work with and have melting temperatures that are not significantly lower than the melting temperature of pure platinum (1769° C). While the lower melting temperature compositions are

easier to work with than the higher melting temperature compositions, all of the compositions are problematic when used to repair platinum jewelry having a platinum content of at least 90% by weight. Specifically, the color of the solder composition does not match the color of the high platinum content jewelry. This results in an unsightly dark seam or spot of solder that must be temporarily masked by plating the seam or spot with rhodium. In addition to adding to the cost and complexity of the jewelry repair, the rhodium plating is also subject to wear over time, whereupon the color difference between the platinum jewelry and the solder composition becomes visible again. Moreover, pitting of the solder at its point of application to the jewelry is often observed, thus further detracting from the appearance of the repaired jewelry.

**[0009]** It is known to add minor amounts of platinum (up to about 5% by weight) to the above-noted solder compositions, but the problems of color matching and pitting still persist. Solder compositions combining palladium and up to 75% by weight platinum have also been employed, but such compositions are characterized by high melting temperatures (1600°C to 1700° C) that are not significantly lower than the 1769° C melting temperature of platinum itself and make the compositions difficult to work with. Additionally, color matching and pitting problems still occur.

**[0010]** Various high platinum content jewelry materials are known in the art. For example, U.S. Patent 4,165,983 discloses an alloy for fabricating jewelry containing at least 95% by weight platinum, 1.5% to 3.5% by weight gallium, and a balance of at least one of indium, gold, palladium, silver, copper, cobalt, nickel, ruthenium, iridium and rhodium. U.S. Patent 5,846,352 discloses a heat-treated platinum-gallium alloy for fabricating jewelry containing 1% to 9% by weight gallium and a small amount of

palladium. However, such alloys are intended for fabricating the jewelry itself. Neither of these patents disclose or suggest particular solder compositions that would be useful for repairing platinum jewelry, and particularly platinum jewelry having a platinum content of up to about 95% by weight.

**[0011]** The standard of fineness for silver products is sterling or standard silver (92.5%). The other 7.5% of the silver alloy content can be any metal but it is usually copper. Similarly, karat gold is an alloy of gold with other metals. Pure gold is very soft unless alloyed into a karat gold such as 18 karat (75% pure) or 22 carat (91.6% pure). The gold alloys may contain several other metallic elements including copper, silver, nickel and zinc to vary the color, the hardness and the melting points.

**[0012]** Currently, there are no known solder compositions for platinum, silver and gold alloys with low flow temperatures that can be used for repairing jewelry having a platinum content of at least 90% by weight, having a silver content of at least 92.5% by weight, and having a gold content of at least 25% to about 91.6% by weight without incurring the above-mentioned problems. Accordingly, the development of a solder composition for such platinum, silver and gold jewelry that does not involve the aforementioned problems would be a significant advance in the art.

#### **BRIEF SUMMARY OF THE INVENTION**

**[0013]** The present invention is directed to a solder composition that can be used for assembling, repairing, and/or sizing jewelry having a platinum content of up to about 95% by weight. In accordance with the invention, such a solder composition consists essentially of about 90% to about 95% by weight platinum and about 5% to about 10%

by weight of an alloy that provides the solder composition with a melting temperature in a range from about 1300° C to about 1500° C.

**[0014]**In accordance with one preferred aspect of the present invention, a solder composition for assembling, repairing, and/or sizing jewelry consists essentially of about 90% to about 95% by weight platinum, about 3% to about 6% by weight gallium, about 1.5% to about 3% by weight indium, and about 0.5% to about 1.0% by weight copper.

**[0015]**In accordance with another preferred aspect of the present invention, a solder composition for assembling, repairing and/or sizing jewelry consists essentially of about 90% to about 95% by weight platinum and about 5% to about 10% by weight of an alloy consisting of gallium, indium and copper in a respective weight ratio of approximately 6:3:1.

**[0016]**In accordance with yet another preferred aspect of the present invention, there is provided an alloy for lowering the melting point of platinum when combined therewith to provide a solder composition having a reduced melting temperature, the alloy consisting essentially of about 60% by weight gallium, about 30% by weight indium and about 10% by weight copper.

**[0017]**Further in accordance with the present invention, there is also provided a method of soldering jewelry containing up to about 95% by weight platinum. The method comprises the step of soldering a piece of jewelry containing up to about 95% by weight platinum with a solder composition consisting essentially of about 90% to about 95% by weight platinum and about 5% to about 10% by weight of an alloy that provides the solder composition with a melting temperature in a range from about 1300° C to about

1500° C In a preferred aspect of the inventive method, the solder composition consists essentially of about 90% to about 95% by weight platinum, about 3% to about 6% by weight gallium, about 1.5% to about 3% by weight indium, and about 0.5% to about 1.0% by weight copper.

**[0018]** In accordance with another preferred aspect of the present invention, a solder composition that can be used for assembling, repairing, and/or sizing jewelry having a silver content of at least about 92.5% by weight. In accordance with the invention, such a solder composition consists essentially of at least about 92.5% by weight silver and about 7.5% of an alloy that provides the solder composition with a melting temperature in a range from about 1100° F to about 1300° F.

**[0019]** In accordance with another preferred aspect of the present invention, a solder composition for assembling, repairing and/or sizing jewelry consists essentially of about 92.5% by weight silver and about 7.5% of an alloy consists essentially of gallium, indium and copper in a respective weight ratio of approximately 6:3:1.

**[0020]** In accordance with another preferred aspect of the present invention, a solder composition that can be used for assembling, repairing, and/or sizing jewelry having a gold content of about 25% to about 91.66% by weight gold. In accordance with the invention, such a solder composition consists essentially of about 25% to about 91.66% by weight gold and about 2% to about 14% of an alloy that provides the solder composition with a melting temperature in a range from about 1000° F to about 1550° F.

**[0021]**In accordance with another preferred aspect of the present invention, a solder composition for assembling, repairing and/or sizing jewelry consists essentially of about 25% (6 karat), 41.66% (10 karat), 58.33% (14 karat), 75% (18 karat) and 91.66% (22 karat) by weight gold and the balance comprising of about 2% to about 14% by weight of gallium, indium and copper in a respective weight ratio of approximately 6:3:1.

**[0022]**In accordance with yet another preferred aspect of the present invention, there is provided an alloy for lowering the melting point of silver when combined therewith to provide a solder composition having a reduced melting temperature, the alloy consists essentially of about 60% by weight gallium, about 30% by weight indium and about 10% by weight copper.

**[0023]**In accordance with yet another preferred aspect of the present invention, there is provided an alloy for lowering the melting point of karat gold when combined therewith to provide a solder composition having a reduced melting temperature, the alloy consists essentially of about 60% by weight gallium, about 30% by weight indium and about 10% by weight copper.

**[0024]**In accordance with the present invention, there is also provided a method of soldering jewelry containing about 25% to about 91.66% by weight gold. The method comprises the step of soldering a piece of jewelry containing about 25% to about 91.66% by weight gold with a solder composition consisting essentially of about 2% to about 14% by weight of an alloy that provides the solder composition with a melting temperature in a range from about 1000° F to about 1550° F.

**[0025]** Further, in accordance with the present invention, there is also provided a method of soldering jewelry containing at least 92.5% silver. The method comprises the step of soldering a piece of jewelry containing at least 92.5% by weight silver with a solder composition consisting essentially of about 92.5% by weight silver and about 7.5% by weight of an alloy that provides the solder composition with a melting temperature in a range from about 1100° F to about 1300° F.

#### DETAILED DESCRIPTION

**[0026]** The present invention provides a solder that is not only easy and safe to use, due to a relatively low flow temperature of 1300° C to 1500° C in relation to the melting temperature of platinum (1769° C), but that also, in use, matches the color of platinum jewelry having a platinum content up to about 95% by weight. These advantages have not previously been found together in a solder composition for platinum jewelry.

**[0027]** In accordance with the present invention, a solder composition containing about 90% to about 95% by weight platinum combined with an alloy that reduces the melting temperature of the solder composition to about 1300° C to about 1500° C eliminates the disadvantages associated with prior art solder compositions for platinum jewelry.

**[0028]** The preferred solder compositions of the present invention contain about 90% to about 95% by weight platinum. The platinum content of the solder composition insures a color match with platinum jewelry containing up to about 95% by weight platinum. It has been found that solder compositions having a platinum content of about 87.5% by weight are unsatisfactory for use in the present invention. In this regard, solder compositions with a platinum content of about 87.5% by weight are too brittle or



“ceramic” to roll and fabricate into useful solders. They turn to dust. Conversely, it has been found that solder compositions having platinum content above 95% by weight can result in useful solders. However, such compositions are extremely hard and possessed of higher melting temperatures, which increase the risk of damage to the platinum jewelry they are used in conjunction with.

**[0029]** The preferred solder compositions of the present invention also contain about 5% to about 10% by weight of an alloy that reduces the melting temperature of the solder composition to about 1300° C to about 1500° C. In this regard, the melting temperature of pure platinum is 1769° C. Accordingly, the alloy reduces the melting temperature of the solder composition sufficiently to facilitate its use while avoiding potential damage to the platinum jewelry.

**[0030]** It has been found that a suitable alloy for use in the present invention is an alloy consisting essentially of about 3% to about 6% gallium, about 1.5% to about 3% indium, and about 0.5% to about 1.0% copper, where all percentages are by weight of the solder composition. A particularly preferred alloy according to the present invention consists essentially of gallium, indium and copper in a respective weight ratio of approximately 6:3:1, or 60% by weight gallium, 30% by weight indium, and 10% by weight copper.

**[0031]** The solder compositions of the present invention provide advantages previously unattained in known solder compositions for high platinum content jewelry.

**[0032]** A primary advantage of the solder compositions of the present invention is accurate color matching between the solder and the platinum jewelry. In this regard,

the color of the disclosed solder compositions matches the color of high platinum content jewelry. Old formula solders result in a color difference between the solder and the jewelry in the form of a dark seam or spot that damages the look of the jewelry and requires rhodium plating to mask the spot. Rhodium plating adds to the complexity and cost of a jewelry repair or assembly job. Moreover, rhodium plating wears off, whereupon the discolored spot appears again and creates an unsightly appearance in the jewelry. The solders of the present invention eliminate dark color and other color difference problems heretofore associated with the repair of high platinum content jewelry, e.g., platinum jewelry containing up to about 95% by weight platinum.

**[0033]** Additionally, it has been found that the solders of the present invention result in less pitting on the joint or spot where the solder is used in relation to prior known solder compositions for platinum jewelry.

**[0034]** The solders of the present invention flow at 1500° C or less, which is much lower than the flow temperature of high platinum content jewelry. Accordingly, 90% to 95% by weight platinum solders are provided that flow at low, workable temperatures. Sizing, assembly and many repairs can be performed on high platinum content jewelry without risk to the integrity of the platinum jewelry itself. Even platinum findings and settings can be assembled with the solder.

**[0035]** The solders of the present invention do not create any problems by polishing out, since the hardness of the solders approximates the hardness of most common platinum alloys. Thus, it is possible to polish assembled, sized or repaired platinum jewelry to smooth and brighten the jewelry without adversely affecting the advantageously

obtained color matching. Polishing of prior art solder compositions for platinum jewelry result in a noticeable residual line or dark spot evidencing the color difference between the jewelry and the solder used on the jewelry. Moreover, the disclosed solders work equally well when used in conjunction with not only conventional platinum but also cobalt/platinum alloys. Further, the solders are free of cadmium, thus avoiding known hazards associated with the use of cadmium in solder compositions.

**[0036]** The solders of the present invention are prepared by melting the platinum and alloy together in specified amounts by any conventional method, e.g., by the known hot torch or electric methods, followed by quenching, rolling and annealing to provide softness to the solder. A hot torch method is preferred. The solder can be manufactured and provided for use in any known form. Such forms include, for example, flat sheets of 0.2mm thickness and predetermined weight and dimension, 1mm diameter round wire, or a paste solder.

**[0037]** The solders of the present invention are ideally used in a method for the assembly, repair, or sizing of jewelry containing up to about 95% by weight platinum. Such methods per se are well known in the art. The particular method of the present invention involves soldering a piece of jewelry containing up to about 95% by weight platinum with a solder composition consisting essentially of about 90% to about 95% by weight platinum and about 5% to about 10% by weight of an alloy that provides the solder composition with a melting temperature in a range from about 1300° C to about 1500° F.

**[0038]** The soldering step of the present invention can take place during the assembly, repair and/or sizing of a piece of high platinum content jewelry. A piece of the solder (e.g., 0.2mm thickness) is cut to a desired size (e.g., 1mm x 1mm), placed with tongs at the desired location on the jewelry, and then melted with a hot torch, whereupon the solder flows into the desired area on the jewelry. Upon removal of the hot torch, the solder rapidly cools, hardens and solidifies.

**[0039]** The potential applications of such a method are many. Thus, for example, a ring from inventory can be adjusted by sizing to a larger or smaller size to fit the finger of a given customer. The solder used to adjust the ring size will match perfectly in color with the color of the original ring. No seams or dark spots are observed at the interface between the solder and the ring. As another example, the solder can be used in jewelry repair jobs, e.g., when replacing a damaged or broken platinum prong on a diamond ring (known as retipping). The solder used in the retipping procedure will match perfectly in color with the color of the ring itself and no dark spots or seams are observed at the solder-jewelry interface. As a final example, the solder can be used in a desired manner during the original assembly of high platinum content jewelry items. The solder matches perfectly in color with the color of the platinum jewelry. No color differences result.

**[0040]** The following Examples 1 to 5 illustrate preferred embodiments of the solder compositions of the present invention, and the method of making and using such solder compositions. Comparative Examples 1 to 5 illustrate known solder compositions for repairing platinum jewelry.

### Example 1

**[0041]**A “hard” plumb platinum solder (melting temperature of approximately 1500° C) is prepared by annealing and rolling. A bar of a solder composition (5.3mm x 0.75 inches; weight of 125 dwt.) consisting of 95% by weight platinum, 3.0% by weight gallium, 1.5% by weight indium, and 0.5% by weight copper is cast with hydrogen and oxygen in an iron upright ingot mold and then quenched in cold water at 40° F. The bar is then rolled from 5.3mm to 1.5mm, annealed on each side for 5 minutes at 1600° F., and quenched in cold water at 40° F. The bar is rolled again from 1.5mm to 0.2mm and quenched again in cold water at 40° F. The solder is then finished in a conventional manner by cutting the 0.2mm strip into pieces of approximately 1.15 dwt. each, which are then each trimmed to 1 dwt. pieces and individually hand-stamped for identification.

**[0042]**This solder is then used in an otherwise known manner to assemble and/or repair jewelry containing from about 90% to about 95% by weight platinum. The melting temperature of the solder (approximately 1500° C) makes it relatively easy to work with. The color of the solder matches well with the jewelry and does not require any further processing. Additionally, there is no pitting observed on the spot where the solder is used. Occasionally, however, the solder is “too white” to perfectly match the color of jewelry containing 90% by weight platinum.

### Example 2

**[0043]**A “medium” plumb platinum solder (melting temperature of approximately 1400° C) is prepared by annealing and rolling in the identical manner to that described in Example 1. The initial solder composition (5.3mm x 0.75 inches; weight of 125 dwt.)

consists of 92.5% by weight platinum, 4.5% by weight gallium, 2.25% by weight indium, and 0.7% by weight copper.

**[0044]** This solder is then used to assemble and/or repair jewelry containing from about 90% to about 95% by weight platinum. The melting temperature of the solder (approximately 1400° C) makes it even easier to work with than the solder of Example 1. The color of the solder matches well with the jewelry and does not require any further processing. Additionally, there is no pitting observed on the spot where the solder is used.

### Example 3

**[0045]** An "easy" plumb platinum solder (melting temperature of approximately 1300° C) is prepared by annealing and rolling. A bar of a solder composition (4.3mm x 17mm; weight of 80 dwt.) consisting of 90% by weight platinum, 6.0% by weight gallium, 3.0% by weight indium, and 1.0% by weight copper is cast with hydrogen and oxygen in an iron upright ingot mold and then quenched in cold water at 40° F. The bar is then rolled from 4.3mm to 4.2mm, annealed on each side for 5 minutes at 1600° F, and quenched in cold water at 40° F. This rolling, annealing and quenching cycle of steps is repeated numerous times to incrementally reduce the bar from 4.2mm to 4.0mm, from 4.0mm to 3.9mm, from 3.9mm to 3.8mm, from 3.8mm to 3.7mm, from 3.7mm to 3.5mm, from 3.5mm to 3.4mm, from 3.4mm to 3.0mm (annealing temperature reduced here to 1400° F.), from 3.0mm to 2.5mm, from 2.5mm to 2.0mm (annealing temperature reduced here to 1300° F.), from 2.0mm to 1.3mm, from 1.3mm to 0.6mm (annealing temperature reduced here to 1100° F.), from 0.6mm to 0.4mm, and finally from 0.4mm to 0.2mm. While cracking of the bar is observed during the multi-step rolling from 4.0mm to

2.0mm, this cracking is ignored and does not affect the final solder composition. The solder is then finished in a conventional manner by cutting into 0.2mm pieces of approximately 1.15 dwt. each, which are then each trimmed to 1 dwt. pieces and individually hand-stamped for identification.

**[0046]** This solder is then used to assemble and/or repair jewelry containing from about 90% to about 95% by weight platinum. The melting temperature of the solder (approximately 1300° C) makes it easy to work with, and easier than the solders of Examples 1 and 2. The color of the solder matches well with the jewelry and does not require any further processing. Additionally, there is no pitting observed on the spot where the solder is used.

#### Example 4

**[0047]** A “medium-hard” plumb platinum solder (melting temperature of between approximately 1400° C and approximately 1500° C) is prepared by annealing and rolling. A bar of a solder composition (5.3mm x 0.75 inches; weight of 125 dwt.) consisting of 94% by weight platinum, 3.6% by weight gallium, 1.8% by weight indium, and 0.6% by weight copper is cast with hydrogen and oxygen in an iron upright ingot mold and then quenched in cold water at 40° F. The bar is then rolled from 5.3mm to 1.5mm, annealed on each side for 5 minutes at 1600° F., and quenched in cold water at 40° F. The bar is rolled again from 1.5mm to 0.2mm and quenched again in cold water at 40° F. The solder is then finished in a conventional manner by cutting the 0.2mm strip into pieces of approximately 1.15 dwt. each, which are then each trimmed to 1 dwt. pieces and individually hand-stamped for identification.

[0048] This solder is then used to assemble and/or repair jewelry containing from about 90% to about 95% by weight platinum. The melting temperature of the solder (between approximately 1400° C and 1500° C) makes it relatively easy to work with. The color of the solder matches well with the jewelry and does not require any further processing. Additionally, there is no pitting observed on the spot where the solder is used.

#### Example 5

[0049] The solder compositions of Examples 1 to 3 are utilized in a step-assembly of high platinum content jewelry. First, the “hard” plumb platinum solder of Example 1 (melting temperature of 1500° C) is used to size a 95% by weight platinum ring to fit the finger of a particular customer. Second, the “medium” plumb platinum solder of Example 2 (melting temperature of 1400° C) is used to repair the ring by filling in an observed hole in the body of the ring. This is accomplished at a temperature (1400° C) that does not melt the solder used in the first sizing step and cause it to fall out. Finally, the “easy” plumb platinum solder of Example 3 (melting temperature of 1300° C) is used to provide a replacement prong for a defective prong that constitutes part of a setting for a diamond on the ring. Again, this retipping step is accomplished at a lower temperature (1300° C) that will not adversely affect the prior two soldering procedures.

#### Comparative Example 1

[0050] A series of known solder compositions for platinum having a melting point of approximately 1300° C are prepared in known manner. These compositions consist of about 77% to about 80% by weight gold and about 20% to about 23% palladium. These solders are then used in a known manner to repair jewelry containing from about 90% to about 95% by weight platinum. The color of these solders does not match well with the



jewelry and the solders must be rhodium-plated to achieve a temporary color match with the jewelry subject to wear over time. Additionally, pitting is observed on the spot where the solder is used.

#### Comparative Example 2

**[0051]**A series of known solder compositions for platinum having a melting point of approximately 1400° C are prepared in known manner. These compositions consist of about 65% to about 74% by weight gold, about 26.5% to about 30% by weight palladium, and 0% to about 5% by weight platinum. These solders are then used in a known manner to repair jewelry containing from about 90% to about 95% by weight platinum. The color of these solders does not match well with the jewelry and the solders must be rhodium-plated to achieve a temporary color match with the jewelry subject to wear over time. Additionally, pitting is observed on the spot where the solder is used.

#### Comparative Example 3

**[0052]**A series of known solder compositions for platinum having a melting point of approximately 1500° C are prepared in known manner. These compositions consist of about 59% to about 70% by weight gold, about 30% to about 39% by weight palladium, and 0% to about 3% by weight platinum. These solders are then used in a known manner to repair jewelry containing from about 90% to about 95% by weight platinum. The color of these solders does not match well with the jewelry and the solders must be rhodium-plated to achieve a temporary color match with the jewelry subject to wear over time. Additionally, pitting is observed on the spot where the solder is used.

#### Comparative Example 4

[0053] A series of known solder compositions for platinum are prepared in known manner. These compositions consist of about 25% to about 92.5% by weight palladium, about 7.5% to about 75% by weight platinum, and 0% to about 30% by weight gold. These solders are then used in a known manner to repair jewelry containing from about 90% to about 95% by weight platinum. The melting temperatures of these solders range from 1600° C to about 1700° C and accordingly are difficult to work with as solder compositions. Additionally, the color of these solders does not match well with the jewelry and the solders must be rhodium-plated to achieve a temporary color match with the jewelry subject to wear over time. Finally, pitting is observed on the spot where the solder is used.

#### Comparative Example 5

[0054] A series of known solder compositions for platinum are prepared in known manner. These compositions consist of about 40% to about 63% by weight gold, about 23% to about 59% by weight silver, 0% to about 1.2% by weight palladium, 0% to about 7% by weight platinum, and 0% to about 0.33% by weight copper. These solders are then used in a known manner to repair jewelry containing from about 90% to about 95% by weight platinum. The melting temperatures of these solders range from about 1000°C to about 1200°C, making the solders easy to work with. However, the color of these solders does not match well with the jewelry and the solders must be rhodium-plated to achieve a temporary color match with the jewelry subject to wear over time.

**[0055]** Moreover, similar solder compositions are used to assemble, repair and size silver and gold containing jewelry. However, the melting point of gold (1064°C) and silver (961.93°C) is considerably lower than that of the melting point of platinum (1772°C). Thus, the lower melting points of gold and silver will reflect the changes in solder melting points, respectively.

Again, although the present invention has been described in terms of the preferred embodiment above, numerous modifications and/or additions to the above-described preferred embodiments would be readily apparent to one skilled in the art.

**[0056]** By way of example, but not limitation, Examples 6-13 serve to further exemplify the scope of the present invention.

#### Example 6

**[0057]** A "22KYE (22 Karat Yellow Easy) Extreme" plumb yellow gold solder comprises a solder composition consisting of about 91.66% by weight 24 karat gold (karating melting temperature of approximately 1615° F) and about 2% to about 14% by weight gallium, indium, and copper in a 6:3:1 ratio, respectively. The solder composition is allowed to cool to 1600° F before being cast with hydrogen and oxygen in a steel upright ingot mold for forming a bar. The solder bar is then allowed to cool to about room temperature (approximately 78° F-80° F). The solder bar is then cleaned by grinding the edges and rolled to a desired thickness. An additional step of annealing is optional depending on desired softness. This rolling, annealing and quenching cycle of steps is repeated numerous times to incrementally reduce the solder bar to a desired thickness. Subsequent to each successive cycle the annealing temperature is reduced

appropriately as shown in previous examples using platinum. The solder is then finished in a conventional manner and individually hand-stamped for identification.

**[0058]** This plumb solder is then used to assemble and/or repair jewelry containing about 91.66% by weight 24-karat gold. The melting temperature of the solder (approximately 1400° F) makes it easy to work with. The color of the solder matches well with the jewelry and does not require any further processing. Additionally, there is no pitting observed on the spot where the solder is used.

**[0059]** Although this example is directed to 22-karat yellow gold, other colors of gold including white, pink, red, or green are within the scope of the present invention.

#### Example 7

**[0060]** A "18KYE (18 Karat Yellow Easy) Extreme" plumb yellow gold solder comprises a solder composition consisting of about 75% by weight 24 karat gold (karating melting temperature of approximately 1615° F), and about 2% to about 14% by weight gallium, indium, and copper in a 6:3:1 ratio, respectively. The solder composition is allowed to cool to 1600° F before being cast with hydrogen and oxygen in a steel upright ingot mold for forming a bar. The solder bar is then allowed to cool to about room temperature (approximately 78° F-80° F). The solder bar is then cleaned by grinding the edges and rolled to a desired thickness. An additional step of annealing is optional depending on desired softness. This rolling, annealing and quenching cycle of steps is repeated numerous times to incrementally reduce the solder bar to a desired thickness. Subsequent to each successive cycle the annealing temperature is reduced

appropriately as shown in previous examples using platinum. The solder is then finished in a conventional manner and individually hand-stamped for identification.

**[0061]** This plumb solder is then used to assemble and/or repair jewelry containing about 75% by weight 24-karat gold. The melting temperature of the solder (approximately 1250° F) makes it easy to work with. The color of the solder matches well with the jewelry and does not require any further processing. Additionally, there is no pitting observed on the spot where the solder is used.

**[0062]** Although this example is directed to 18-karat yellow gold, other colors of gold including white, pink, red, or green are within the scope of the present invention.

#### Example 8

**[0063]** A "14KWE (14 Karat White Easy) Extreme" plumb white gold solder comprises a solder composition consisting of about 58.33% by weight 24 karat gold (melting temperature of approximately 1615° F), and about 2% to about 14% by weight gallium, indium, and copper in a 6:3:1 ratio, respectively. The solder composition is allowed to cool to 1600° F before being cast with hydrogen and oxygen in a steel upright ingot mold for forming a bar. The solder bar is then allowed to cool to about room temperature (approximately 78° F-80° F). The solder bar is then cleaned by grinding the edges and rolled to a desired thickness. An additional step of annealing is optional depending on desired softness. This rolling, annealing and quenching cycle of steps is repeated numerous times to incrementally reduce the solder bar to a desired thickness. Subsequent to each successive cycle the annealing temperature is reduced

appropriately as shown in previous examples using platinum. The solder is then finished in a conventional manner and individually hand-stamped for identification.

**[0064]** This plumb solder is then used to assemble and/or repair jewelry containing about 58.33% by weight 24-karat gold. The melting temperature of the solder (approximately 1175° F) makes it easy to work with. The color of the solder matches well with the jewelry and does not require any further processing. Additionally, there is no pitting observed on the spot where the solder is used.

**[0065]** Although this example is directed to 14-karat white gold, other colors of gold including yellow, pink, red, or green are within the scope of the present invention.

#### Example 9

**[0065]** A "18KWE (18 Karat White Easy) Extreme" plumb white gold solder comprises a solder composition consisting of about 75% by weight 24 karat gold (karating melting temperature of approximately 1615° F), and about 2% to about 14% by weight gallium, indium, and copper in a 6:3:1 ratio, respectively. The solder composition is allowed to cool to 1600° F before being cast with hydrogen and oxygen in a steel upright ingot mold for forming a bar. The solder bar is then allowed to cool to about room temperature (approximately 78° F-80° F). The solder bar is then cleaned by grinding the edges and rolled to a desired thickness. An additional step of annealing is optional depending on desired softness. This rolling, annealing and quenching cycle of steps is repeated numerous times to incrementally reduce the solder bar to a desired thickness. Subsequent to each successive cycle the annealing temperature is reduced

appropriately as shown in previous examples using platinum. The solder is then finished in a conventional manner and individually hand-stamped for identification.

**[0067]** This plumb solder is then used to assemble and/or repair jewelry containing about 75% by weight 24-karat gold. The melting temperature of the solder (approximately 1350° F) makes it easy to work with. The color of the solder matches well with the jewelry and does not require any further processing. Additionally, there is no pitting observed on the spot where the solder is used.

**[0068]** Although this example is directed to 18-karat white gold, other colors of gold including yellow, pink, red, or green are within the scope of the present invention.

#### Example 10

**[0069]** A "14KPE (14 Karat Pink Easy) Extreme" plumb pink gold solder comprises a solder composition consisting of about 58.33% by weight 24 karat gold, (melting temperature of approximately 1615° F), and about 2% to about 14% by weight gallium, indium, and copper in a 6:3:1 ratio, respectively. The solder composition is allowed to cool to 1600° F before being cast with hydrogen and oxygen in a steel upright ingot mold for forming a bar. The solder bar is then allowed to cool to about room temperature (approximately 78° F-80° F). The solder bar is then cleaned by grinding the edges and rolled to a desired thickness. An additional step of annealing is optional depending on desired softness. This rolling, annealing and quenching cycle of steps is repeated numerous times to incrementally reduce the solder bar to a desired thickness. Subsequent to each successive cycle the annealing temperature is reduced

appropriately as shown in previous examples using platinum. The solder is then finished in a conventional manner and individually hand-stamped for identification.

**[0070]** This plumb solder is then used to assemble and/or repair jewelry containing about 58.33% by weight 24-karat gold. The melting temperature of the solder (approximately 1550° F) makes it easy to work with. The color of the solder matches well with the jewelry and does not require any further processing. Additionally, there is no pitting observed on the spot where the solder is used.

**[0071]** Although this example is directed to 14-karat pink gold, other colors of gold including yellow, white, red, or green are within the scope of the present invention.

#### Example 11

**[0072]** A "10KYXE (10 Karat Yellow Easy) Extreme" plumb yellow gold solder comprises a solder composition consisting of about 41.66% by weight 24 karat gold, base metals, plus about 2% to about 14% gallium, indium and copper (karating melting temperature of approximately 1665° F). The solder composition is allowed to cool to 1600° F before being cast with hydrogen and oxygen in a steel upright ingot mold for forming a bar. The solder bar is then allowed to cool to about room temperature (approximately 78° F-80° F). The solder bar is then cleaned by grinding the edges and rolled to a desired thickness. Rolling the solder bar reduces it by 80%. Then an annealing step is performed at 1000°F for 20 minutes. The solder bar is then further cooled to about room temperature (approximately 78°F-80°F), then immersed in 95% water plus 5% sparex. The solder bar is then rinsed and scrubbed using a steel brush. The solder bar is then further rolled down to a desired thickness. The solder is finished in a



conventional manner and individually hand-stamped for identification. The solder is then finished in a conventional manner and individually hand-stamped for identification.

**[0073]** This plumb solder is then used to assemble and/or repair jewelry containing about 41.66% by weight 24-karat gold. The melting temperature of the solder (approximately 1100° F) makes it easy to work with. The color of the solder matches well with the jewelry and does not require any further processing. Additionally, there is no pitting observed on the spot where the solder is used.

**[0074]** Although this example is directed to 10-karat yellow gold, other colors of gold including white, pink, red, or green are within the scope of the present invention.

#### Example 12

**[0075]** A "10KWE (10 Karat White Easy) Extreme" plumb white gold solder comprises a solder composition consisting of about 41.66% by weight 24 karat gold, base metals, plus about 2% to about 14% by weight gallium, indium and copper in a 6:3:1 ratio, respectively (melting temperature of approximately 1665° F). The solder composition is allowed to cool to 1600° F before being cast with hydrogen and oxygen in a steel upright ingot mold for forming a bar. The solder bar is then allowed to cool to about room temperature (approximately 78° F-80° F). The solder bar is then cleaned by grinding the edges and rolled to a desired thickness. Rolling the solder bar reduces it by 80%. Then an annealing step is performed at 1000°F for 20 minutes. The solder bar is then further cooled to about room temperature (approximately 78°F-80°F), then immersed in 95% water plus 5% spandex. The solder bar is then rinsed and scrubbed using a steel brush. The solder bar is then further rolled down to a desired thickness.

The solder is finished in a conventional manner and individually hand-stamped for identification. The solder is then finished in a conventional manner and individually hand-stamped for identification.

**[0076]** This plumb solder is then used to assemble and/or repair jewelry containing about 41.66% by weight 24-karat gold. The melting temperature of the solder (approximately 1100° F) makes it easy to work with. The color of the solder matches well with the jewelry and does not require any further processing. Additionally, there is no pitting observed on the spot where the solder is used.

**[0077]** Although this example is directed to 10-karat white gold, other colors of gold including yellow, pink, red, or green are within the scope of the present invention.

#### Example 13

**[0078]** A "below extra easy" plumb silver solder comprises of a solder composition of consisting of least 92.5% by weight silver, 4.5% by weight gallium, 2.25% by weight indium, and 0.75% by weight copper (melting temperature of approximately 1665° F). The solder composition is allowed to cool to 1600° F before being cast with hydrogen and oxygen in a steel upright ingot mold for forming a bar. The solder bar is then allowed to cool to about room temperature (approximately 78° F-80° F). The solder bar is then cleaned by grinding the edges and rolled to a desired thickness. An additional step of annealing is optional depending on desired softness. This rolling, annealing and quenching cycle of steps is repeated numerous times to incrementally reduce the solder bar to a desired thickness. Subsequent to each successive cycle the annealing temperature is reduced appropriately as shown in previous examples using platinum.

The solder is then finished in a conventional manner and individually hand-stamped for identification.

**[0079]** This plumb solder is then used to assemble and/or repair jewelry containing at least 92.5% by weight silver. The melting temperature of the solder (approximately 1100° F) makes it easy to work with. The color of the solder matches well with the jewelry and does not require any further processing. Additionally, there is no pitting observed on the spot where the solder is used.

**[0080]** While the present invention has been disclosed and described with respect to particular and preferred embodiments, various modifications and alternatives will be apparent and will suggest themselves to those of ordinary skill in the art. Such modifications and alternatives do not depart from and are within the spirit and scope of the present invention, which is only to be limited as set forth in the appended claims.